

U.S. Patent Application No. 09/933,610
Amendment dated July 28, 2003
Reply to Office Action dated April 28, 2003

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

Claim 1. (currently amended): A composition comprising at least one powdered material admixed with at least one thermally decomposable polyhydroxyalkanoate having a molecular weight of from about 500 to less than ~~70,000~~ 10,000.

Claim 2. (canceled).

Claim 3. (canceled).

Claim 4. (original): The composition of claim 1, wherein the molecular weight is from about 1,000 to about 5,000.

Claim 5. (original): The composition of claim 1, wherein the molecular weight is from about 1,000 to about 3,000.

Claim 6. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is a polymer of one or more subunits having the chemical formula:



wherein n is 0 or an integer, and wherein R¹, R², R³, or R⁴, which is the same or different, is selected from a saturated or unsaturated hydrocarbon radical; a halo- or hydroxy-substituted radical; a hydroxy radical; a halogen radical; a nitrogen-substituted radical; an oxygen-substituted radical; or a hydrogen atom.

Claim 7. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is selected from poly(3-hydroxybutyrate), poly 3-hydroxybutyrate-co-3-hydroxyvalerate, poly 3-

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hydroxybutyrate-co-4-hydroxybutyrate, poly 3-hydroxybutyrate-co-3-hydroxyhexanoate, poly 3-hydroxybutyrate-co-3-hydroxyheptanoate, or poly 3-hydroxybutyrate-co-3-hydroxyoctanoate.

Claim 8. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is produced by a microbial fermentation process.

Claim 9. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is produced by a genetically engineered plant crop system.

Claim 10. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is produced by a chemical polymerization reaction.

Claim 11. (original): The composition of claim 10, wherein the chemical polymerization reaction is a ring opening polymerization reaction.

Claim 12. (original): The composition of claim 1, wherein the polyhydroxyalkanoate comprises a polymer selected from the group consisting of poly(lactic acid)s, poly(glycolic acid)s, 3-hydroxyacids, 4-hydroxyacids, 5-hydroxyacids, copolymers thereof, and blends thereof.

Claim 13. (original): The composition of claim 1, wherein the powdered material is selected from glass, ceramics, metals, alloys, or mixtures thereof.

Claim 14. (original): The composition of claim 13, wherein the powdered material is present in an amount of from about 50 % to about 99.999 % by weight based on total dry weight of the composition.

Claim 15. (original): The composition of claim 13, wherein the powdered material is a ceramic present in an amount of from about 70 % to about 99.999 % by weight based on total dry weight of the composition.

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Claim 16. (original): The composition of claim 1, wherein the polyhydroxyalkanoate comprises a mixture of thermally degradable polyhydroxyalkanoates.

Claim 17. (original): The composition of claim 1, further comprising at least one thermally degradable polymer other than polyhydroxyalkanoate.

Claim 18. (original): The composition of claim 17, wherein the thermally degradable polymer is selected from polycarbonates, polyolefins, polystyrenes, polyacetals, waxes, or combinations thereof.

Claim 19. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is dispersed in water.

Claim 20. (original): The composition of claim 1, wherein the polyhydroxyalkanoate is dissolved in a solvent or a mixture of solvents.

Claim 21. (original): A method of forming a shaped product, the method comprising:

molding a composition comprising a powdered material admixed with at least one thermally decomposable polyhydroxyalkanoate of claim 1 or a solution thereof to form the shaped product.

Claim 22. (original): The method of claim 21, wherein the powdered material is selected from glass, ceramics, metals, alloys, or mixtures thereof.

Claim 23. (original): The method of claim 21, wherein the method of forming shaped products is selected from slip casting, tape casting, extrusion, injection molding, dry pressing, or screen printing.

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Claim 24. (original): The method of claim 21, further comprising heating the shaped product to remove essentially all of the polyhydroxyalkanoate from the product.

Claim 25. (original): A molded article formed by a method comprising:
molding a composition comprising a powdered material admixed with at least one thermally decomposable polyhydroxyalkanoate of claim 1 or a solution thereof.

Claim 26. (currently amended): A molding composition comprising 70 wt% to 99.9 wt% of an inorganic material and 0.1-30 wt% of at least one polyhydroxyalkanoate having a molecular weight from 500 to less than ~~70,000~~ 10,000 and the chemical formula:



where n is 0 or an integer, and wherein R¹, R², R³, and R⁴, which are the same or different, are selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.

Claim 27. (currently amended): The molding composition of claim 26, wherein the inorganic material comprises iron, chromium, copper, nickel, ~~aluminium~~ aluminum, titanium, silicon oxide, silicon carbide, silicon nitride, or aluminum nitride.

Claim 28. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is polyhydroxybutyrate.

Claim 29. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is a copolymer of 60-99 wt% 3-hydroxybutyric acid and 1-40 wt% 3-hydroxyvaleric acid.

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Claim 30. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is a copolymer of 60-99 wt% 3-hydroxybutyric acid and 1-40 wt% 4-hydroxybutyric acid

Claim 31. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is poly 3-hydroxyoctanoate.

Claim 32. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is a copolymer containing at least 10 wt% by molar mass hydroxyoctanoate groups randomly distributed through the polymer chain.

Claim 33. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate has a molecular weight of from about 1,000 to about 9,000.

Claim 34. (currently amended): The molding composition of claim 26, wherein the polyhydroxyalkanoate has a molecular weight of from about 1,000 to less than about ~~70,000~~ 3,000.

Claim 35. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate has an end chain functionality selected from vinyl, carboxylic acid, carboxylic acid ester, acetate, butyrate, propanoate, primary, secondary or tertiary alcohol, amide, or polyhydric alcohol.

Claim 36. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the thermolysis of a polyhydroxyalkanoate having a molecular weight greater than 80,000.

Claim 37. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate has the structure $R^5CH=CH_2(CH_2)_{n-1}CO[OCHR^6(CH_2)_nCO]_pOH$, where p is from 5 to 1000, n is 0 or an integer, and R^5 and R^6 , which are the same or different, is

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selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.

Claim 38. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the acid hydrolysis of a polyhydroxyalkanoate having a molecular weight of greater than 80,000.

Claim 39. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the acid hydrolysis of a polyhydroxyalkanoate having a molecular weight of greater than 80,000 in the presence of an alcohol, diol or polyhydric alcohol.

Claim 40. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate has the structure $H[OCHR^7(CH_2)_n CO]_pOR'$, wherein R' is derived from a monohydric alcohol or a polyhydric alcohol and wherein p is from 5 to 1000, n is 0 or an integer, and R^7 is selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.

Claim 41. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the acid hydrolysis of a polyhydroxyalkanoate having a molecular weight of greater than 80,000 in the presence of an aliphatic carboxylic acid.

Claim 42. (original): A molding composition of claim 26, wherein the polyhydroxyalkanoate has the structure $R''CO[OCHR^8(CH_2)_n CO]_pOH$, wherein R'' is derived from a carboxylic acid having 1 to 20 carbon atoms and wherein p is from 5 to 1000, n is 0 or an integer, and R^8 is selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.

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Claim 43. (original): The molding composition of claim 26, wherein the polyhydroxyalkanoate is a block polymer containing at least 20 wt% of a polyhydroxyalkanoate segment and at least one polyalkylene glycol segment where the polyalkylene glycol is selected from one or more repeat units of ethylene oxide, propylene oxide or butylene oxide or mixtures of ethylene oxide, propylene oxide and/or butylene oxide.

Claim 44. (original): A thermally decomposable polyhydroxyalkanoate having at least one of the terminal end groups selected from:

- a) $-\text{CO}-\text{CH}=\text{CR}^9\text{R}^{10}$;
- b) $-\text{OR}^{11}$;
- c) $-\text{COOR}^{12}$,
- d) $-\text{COR}^{13}$; or
- e) $-\text{OM}^+$

wherein R^9 , R^{10} , R^{11} , R^{12} , or R^{13} which are the same or different, represents saturated or unsaturated hydrocarbon radicals, halo- or hydroxy- substituted radicals, hydroxy radicals, nitrogen-substituted radicals, oxygen-substituted radicals, or a hydrogen atom, with the proviso that R^{11} is not a hydrogen atom, and M^+ is a counter ion.

Claim 45. (original): The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said second terminal end group is $-\text{CO}-\text{CH}=\text{CR}^9\text{R}^{10}$.

Claim 46. (original): The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said second terminal end group is $-\text{OR}^{11}$.

Claim 47. (original): The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said second terminal end group is $-\text{COOR}^{12}$.

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Claim 48. (original): The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said polyhydroxyalkanoate has a molecular weight of from about 500 to less than 70,000

Claim 49. (original): The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said polyhydroxyalkanoate has a molecular weight of from about 10,000 to about 1.5 million.

Claim 50. (original): A composition comprising at least one powdered material admixed with the thermally decomposable polyhydroxyalkanoate of claim 44.

Claim 51. (original): A method of making the thermally decomposable polyhydroxyalkanoate of claim 44, comprising subjecting a thermally decomposable polyhydroxyalkanoate having a molecular weight of greater than 70,000 to an acid hydrolysis.

Claim 52. (original): A method of making the thermally decomposable polyhydroxyalkanoate of claim 44, comprising subjecting a thermally decomposable polyhydroxyalkanoate having a molecular weight of greater than 70,000 to a heat profile to decompose the polyhydroxyalkanoate

Claim 53. (original): The method of claim 52, wherein said thermolysis occurs at a temperature of from about 195°C to about 250°C at atmospheric pressure.

Claim 54. (original): The method of claim 53, wherein said thermolysis occurs for a period of from about 15 seconds to about 4 hours.

Claim 55. (original): The method of claim 51, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass containing inorganic salts.

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Claim 56. (original): The method of claim 51, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass washed free of water soluble salts.

Claim 57. (original): The method of claim 51, wherein said thermally decomposable polyhydroxyalkanoate is a purified polymer.

Claim 58. (original): The method of claim 51, wherein the yield is greater than 80 % by weight based on the polyhydroxyalkanoate content.

Claim 59. (original): The method of claim 52, wherein said method occurs in an inert gas.

Claim 60. (original): The method of claim 52, wherein said method occurs in a reducing atmosphere.

Claim 61. (original): The method of claim 52, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass containing inorganic salts.

Claim 62. (original): The method of claim 52, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass washed free of water soluble salts.

Claim 63. (original): The method of claim 52, wherein said thermally decomposable polyhydroxyalkanoate is a purified polymer.

Claim 64. (original): A method of claim 51, wherein said acid hydrolysis occurs in the presence of an alcohol, a diol, a polyhydric alcohol, or combinations thereof.

Claim 65. (original): The method of claim 51, wherein said hydrolysis occurs in an excess amount of alcohol, diol, thiol, or combinations thereof.

Claim 66. (original): The method of claim 65, wherein at least 1 % by weight residual alcohol, diol, or polyol remains in the reaction product.

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Claim 67. (original): The method of claim 59, wherein said inert gas is a nitrogen gas optionally in the presence of an alcohol vapor.

Claim 68. (original): The composition of claim 1, wherein said powdered material is a metal powder comprising iron, steel, copper, nickel, tungsten, or combinations thereof and said polyhydroxybutyrate comprises poly 3 hydroxybutyrate or a copolymer of 3 hydroxy butyrate with 3 hydroxyvalerate or 4 hydroxybutyrate.

Claim 69. (original): The composition of claim 1, wherein said powdered material is a ceramic powder comprising barium titanate, aluminum hydroxide, alumina, wollastonite, silica, or combinations thereof and said polyhydroxybutyrate comprises poly 3 hydroxybutyrate or a copolymer of 3 hydroxy butyrate with 3 hydroxyvalerate or 4 hydroxybutyrate.